Reputation, Bailouts, and Interest Rate Spread Dynamics

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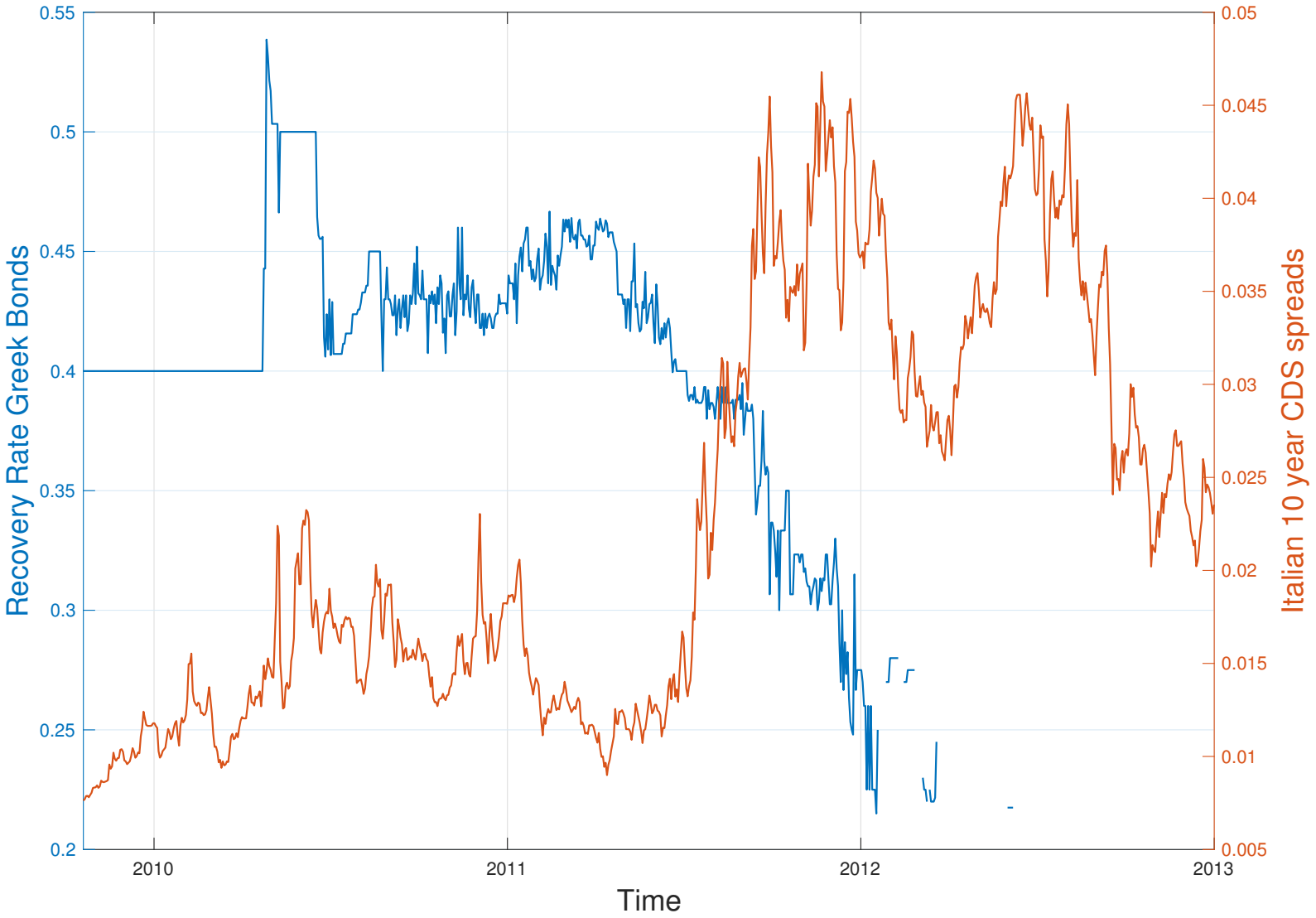
Motivation

European debt crisis

- 2000-2009:
  - All EMU members borrow at low rates
  - Despite different fundamentals
- Crisis starts in Greece:
  - No immediate bailout, lenders forced to get a haircut
  - Contagion to other member states

Haircut in Greece ⇒ High Spread in Italy



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- Crisis worsens
  - OMT announcement
  - Interest rates goes down despite crisis more severe

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Similar dynamics:

- 2008 financial crisis
- EU banking union (SRM)
- Puerto Rico (Chirinko et al., 2019)

This Paper

- Time varying expectations of bailouts from common "bailout authority" driver of interest rate spreads

- Build model where time varying bailout expectations endogenous
  - Reputation model with learning about type of bailout authority
  - Can be either a commitment type or a no-commitment type
  - Agents learn about type by observing bailouts

- Equilibrium outcome consistent with our narrative
  - Hump-shaped spreads dynamics
  - Contagion
  - Delayed bailouts

Mechanism

- Normal times:
  - No need to bailout, no learning about type of bailout authority
- Crisis starts (for a small number of borrowers):
  - Static incentives to bailout ↑ but good time to increase reputation
  - No-commitment type mixes between bailout and no bailout
  - If no bailout: revise probability of receiving bailout downward
    ⇒ increase in spreads and contagion
    ⇒ spreads more sensitive to fundamentals
- Crisis becomes more severe (more borrowers affected):
  - Static incentive to bailout too large
  - No-commitment type bails out
  - Private agents revise probability of receiving bailout upward
    ⇒ decrease in spreads for all borrowers despite crisis is more severe

Related Literature

- Repeated games with behavioral types
  - Kreps and Wilson (1982), Milgrom and Roberts (1982)
- Reputation and default
  - Cole et al. (1995), D'Erasmo (2008)
- Bailout and asset prices
  - Kelly, Lustig, and Van Nieuwerburgh (2016)
- Phelan (2006)
  - Phelan: High reputation $\Rightarrow$ high temptation for gov't
  - Our paper: High reputation $\Rightarrow$ low temptation for gov't
- Nosal and Ordonez (2016)
  - Their paper: Gov't learns about state of the economy
  - Our paper: Private agents learns about type of gov't

  Cannot account for jump in spreads if no bailout

MODEL

Environment

- $\tau = 0, 1, 2, ..., \infty$
- Each period has two sub-periods, $t = 1, 2$
- State $s \in S$ realized in second sub-period with prob. $p(s)$
  - For now, s iid over time
  - Introduce persistence later
- Economy populated by
  - Borrowers (local gov'ts, EU members)
  - Lenders
  - Tax-payers
  - Bailout authority

Borrowers and Lenders

- Borrowers
  - In sub-period 1, have endowment y
  - In sub-period 2, they draw endowment θ with prob. $h(\cdot|s)$
  - Preferences

$$u(c_1) + \delta \sum_s \sum_\theta u(c_2(s,\theta))h(\theta|s)p(s)$$

- Lenders
  - Endowments in both sub-periods
  - Preferences

$$x_1 + q \sum_s \sum_\theta x_2(s,\theta)h(\theta|s)p(s)$$

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- Borrowers can borrow from lenders
  - Non-contingent debt
  - Cannot commit to repay
  - Default has private output cost $\chi(s,\theta) \Rightarrow$ default value $\underline{u}(s,\theta)$

Example

- Borrowers endowments $\theta \in \{\theta_H, \theta_L\}$
- Aggregate state can take on 3 values: $s \in \{s_L, s_M, s_H\}$
  - s_H "normal times": $h(\theta_H|s_H) = 1$
  - s_M "mild crisis": $h(\theta_H|s_M) = 1 - \mu$, $h(\theta_L|s_M) = \mu$
  - s_L "severe crisis": $h(\theta_L|s_L) = 1$
- Default costs are extremely convex

$$\underline{u}_i(s, \theta) = \begin{cases} u(0) & \text{if } \theta = \theta_H \\ u(\theta_L) & \text{if } \theta = \theta_L \end{cases}$$

Bailout Authority

- It can be one of two types
  - Commitment type (c): never bails out
  - No-Commitment type (nc): chooses whether to bailout or not

- Type changes over time
  - p_c: probability c-type stays
  - p_{nc}: probability nc-type replaced by c-type

- Objective: lenders + tax-payers utility - social default costs
  - Social default costs are $C(\Delta B)$ where
    - Δ is aggregate default rate
    - B is average debt
    - $C(\cdot)$ is increasing

    Stand in for costs associated with reduction in lenders' net-worth

- Discount across periods β

Timing and Actions

Focus on symmetric Markov equilibria

- State: π, posterior probability facing c-type

Timing in each period

- In sub-period 1: Borrowers choose debt, b, given bond schedule Q
- In sub-period 2: s and θ are realized
- Bailout authority chooses transfers $\mathsf{T}(\mathsf{b}, \theta)$
  - Transfers contingent on full debt repayment by borrowers
- Borrower decides whether to default or not
- Prior is updated

CHARACTERIZATION

Bailout Authority

In sub-period 2, given (π, s) and a distribution Γ over (b, θ), bailout authority chooses transfers to solve

$$W_2(\pi, \Gamma, s) = \max_{T(b,\theta),\Delta} \quad (1-\Delta)B - \int_b \sum_\theta T(b,\theta)h(\theta|s)d\Gamma(b) \\ -C(\Delta B) + \beta W(\pi')$$

subject to

$$\Delta = \Pr\{u(\theta - b + T(b,\theta)) < \underline{u}(s,\theta)|s\}$$

where

- $W(\pi')$ is the continuation value
- π' is posterior

Bailout Authority, cont.

- Continuation value

$$W(\pi) = -Q(\pi, B(\pi))\, B(\pi) + q \sum_{s} p(s) W_2(B(\pi), B(\pi), s)$$

- The new posterior $\pi' = \pi'(\pi, B, s)$ follows Bayes' rule:

$$\pi' = \begin{cases} p_{nc} + \frac{\pi}{\pi + (1-\pi)\Pr(T(\pi,B,s)=0)} (p_c - p_{nc}) & \text{if } T = 0 \\ p_{nc} & \text{if } T \neq 0 \end{cases}$$

Optimal Transfers

- Transfers $\mathsf{T}(\pi, \Gamma, s)(b, \theta)$ are either zero for all (b, θ) or

$$\mathsf{T}^*(b, \theta) = \max\left\{\mathfrak{u}^{-1}\left(\underline{\mathfrak{u}}(s, \theta)\right) - \theta + b, 0\right\}$$

  That is, either
  - Mimics c-type, or
  - Choose statically optimal transfers:
    Transfer the minimal amount required to avoid default
    (Consider limit of N borrowers economy)

- Let σ be the probability choose T^* i.e. it bails out

Optimal Transfers, cont.

Optimal to chooses T^* (or to bailout) iff

$$-C(0) + \beta W(p_{nc}) \geqslant -C(\Delta(B, s)B) + \beta W(\pi')$$

$$\iff \Delta\Omega(B, s) \equiv C(\Delta(B, s)B) - C(0) \geqslant \beta[W(\pi') - W(p_{nc})]$$

Compare

- Static benefit: bailout $\Rightarrow$ no default costs C
- Dynamic loss: bailout $\Rightarrow$ loss of reputation

Equilibrium Bailout Probability

Let $\Delta p = p_c - p_{nc}$

- If $\beta\left[W_1\left(p_{nc} + \pi\Delta p\right) - W_1\left(p_{nc}\right)\right] \geqslant \Delta\Omega\left(\pi, s|\,\sigma\right)$ then $\sigma(\pi, s) = 0$
- If $\beta\left[W_1\left(p_c\right) - W_1\left(p_{nc}\right)\right] < \Delta\Omega\left(\pi, s|\,\sigma\right)$ then $\sigma(\pi, s) = 1$
- Else $\sigma(\pi, s)$ solves

$$\beta\left[W_1\left(p_{nc} + \frac{\pi\Delta p}{\pi + (1-\pi)(1-\sigma)}\right) - W_1\left(p_{nc}\right)\right] = \Delta\Omega\left(\pi, s|\sigma\right)$$

Borrower's Problem

- Since $T \in \{T^*, 0\}$, borrower's value in sub-period 2 does not depend on T and is given by

$$\max\{u(\theta - b), \underline{u}(s, \theta)\}$$

  - Transfer such that $u(\theta - b + T) = \underline{u}(s, \theta)$

- Borrower's problem in sub-period 1 is

$$\max_{c,b} u(c) + \delta \sum_s \sum_\theta \max\{u(\theta - b), \underline{u}(s, \theta)\} h(\theta|s) p(s)$$

subject to

$$c \leqslant Y + Q(\pi, b) b$$

where $Q(\pi, \cdot)$ is the bond price schedule from lenders' zero-profits

Debt Price and Debt in Example

- Probability borrower repays absent transfers is

$$P^{\text{repay}} = \sum_{s} h(\theta_H|s)p(s)$$

- Probability a borrower is bailed out is

$$P^{\text{bailout}}(\pi) = (1-\pi)\sum_{s} \sigma(\pi, B(\pi), s)h(\theta_L|s)p(s)$$

- Debt price is

$$Q(\pi) = q\left[P^{\text{repay}} + P^{\text{bailout}}(\pi)\right]$$

  if $B \leqslant \theta_H$ and 0 otherwise

- Debt $B(\pi)$ solves

$$Q(\pi)u'(Y + Q(\pi)B(\pi)) = \delta P^{\text{repay}} u'(\theta_H - B(\pi))$$

Markov Equilibrium

An equilibrium is i) debt issuance policy $\mathsf{b}(\pi)$, ii) debt price $\mathsf{Q}(\pi, \cdot)$, iii) government bailout probability σ and value W, iv) law motion for beliefs, v) aggregate debt $\mathsf{B}(\pi)$ such that

- $\mathsf{b}(\pi)$ solves borrower's problem
- Q satisfies lenders' no-arbitrage condition
- σ solves gov't problem
- law motion for beliefs satisfies Bayes' rule
- $\mathsf{b}(\pi) = \mathsf{B}(\pi)$

Existence of Monotone Equilibrium

Proposition

If p_{nc} *is sufficiently small, there exists a continuous monotone equilibrium in which*

- $\sigma(\pi, s)$ *is decreasing*
- $W(\pi)$ *is increasing*
- $B(\pi)$ *is decreasing*
- $Q(\pi, B(\pi))$, *is strictly decreasing*

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Mechanical proof:

- Define operator whose fixed point is equilibrium
- Apply Tarski's fixed point theorem

Bailout Probability Decreasing in Reputation

Recall if $\sigma(\pi, s)$ interior it solves

$$\beta\left[W_1\left(p_{nc}+\frac{\pi\Delta p}{\pi+(1-\pi)(1-\sigma)}\right)-W_1\left(p_{nc}\right)\right]=\Delta\Omega\left(\pi, s|\sigma\right)$$

- When reputation is low $\Rightarrow$ high temptation to bailout
  - Higher static benefits: when π is high, debt is high $B(\pi)$
  - Lower dynamic losses: $W(\pi)$ increasing
- $\Rightarrow$ $\sigma(\pi, s)$ is decreasing in π
- Potential for multiplicity and "reputation trap"
  - But same properties within class

Debt Prices Decreasing in Reputation

- Recall debt price is

$$Q(\pi) = q\left[P^{\text{repay}} + P^{\text{bailout}}(\pi)\right]$$

where

$$P^{\text{bailout}}(\pi) = (1-\pi)\sum_{s}\sigma(\pi, B(\pi), s)h(\theta_L|s)p(s)$$

- Since $\sigma(\pi, s)$ is decreasing in reputation
  $\Rightarrow P^{\text{bailout}}(\pi)$ is decreasing in reputation
  $\Rightarrow Q(\pi)$ is decreasing in reputation

- Note in discrete example P^{repay} does not depend on π
  - This is because it does not depend on b
  - In general need assumptions

Optimal to Mix in a Mild Crisis

Proposition

For intermediate values of β*, if* $p_c \to 1$ *and* $p_{nc} \to 0$ *then in any monotone continuous equilibrium:*

- *It is optimal to bailout with probability one in a severe recession,* $\sigma(\pi, s_L) = 1$ *for all* π
- *It is optimal to mix in a mild recession for some values of* π

Equilibrium Bailout Probability

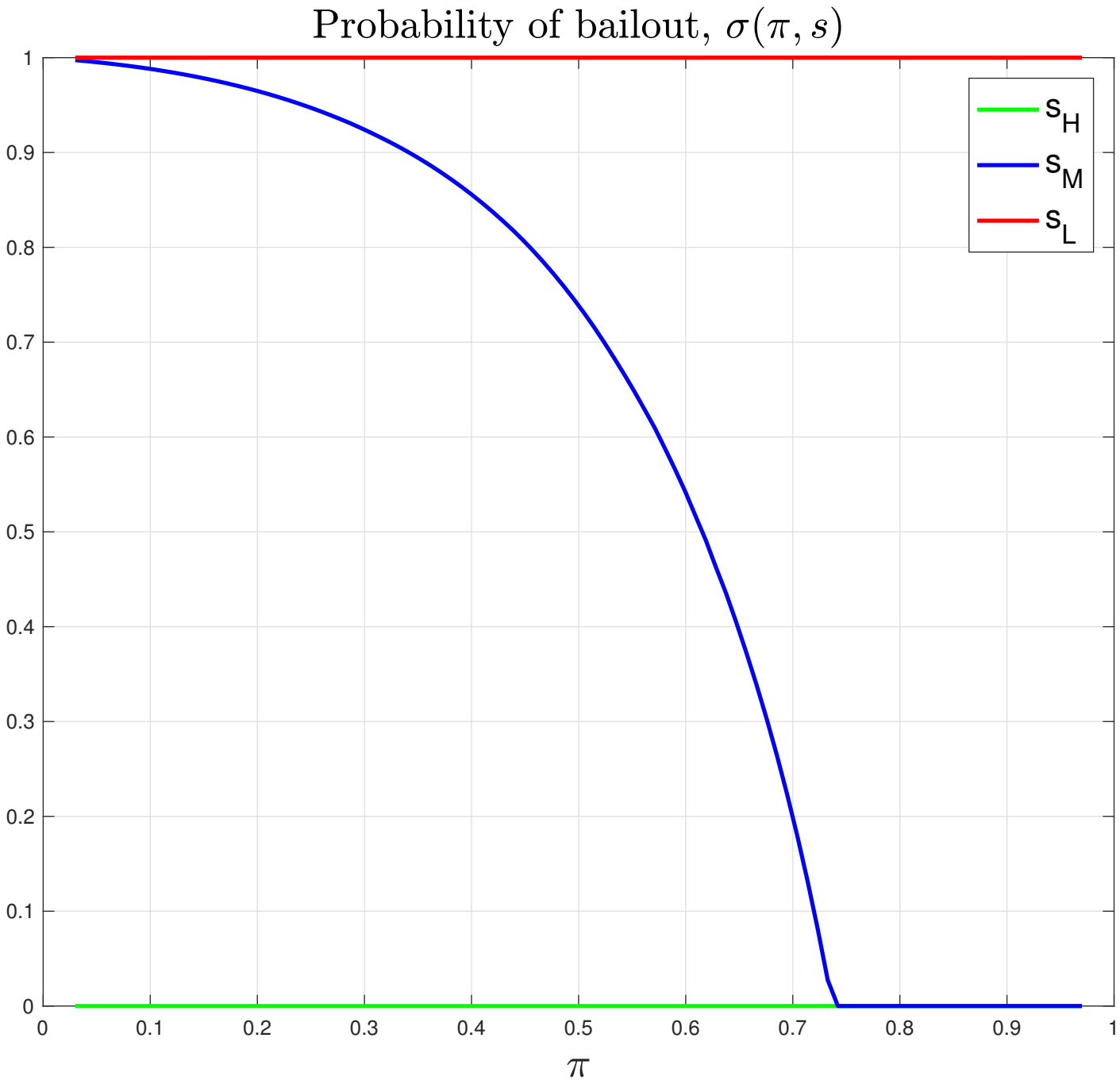
Recall:

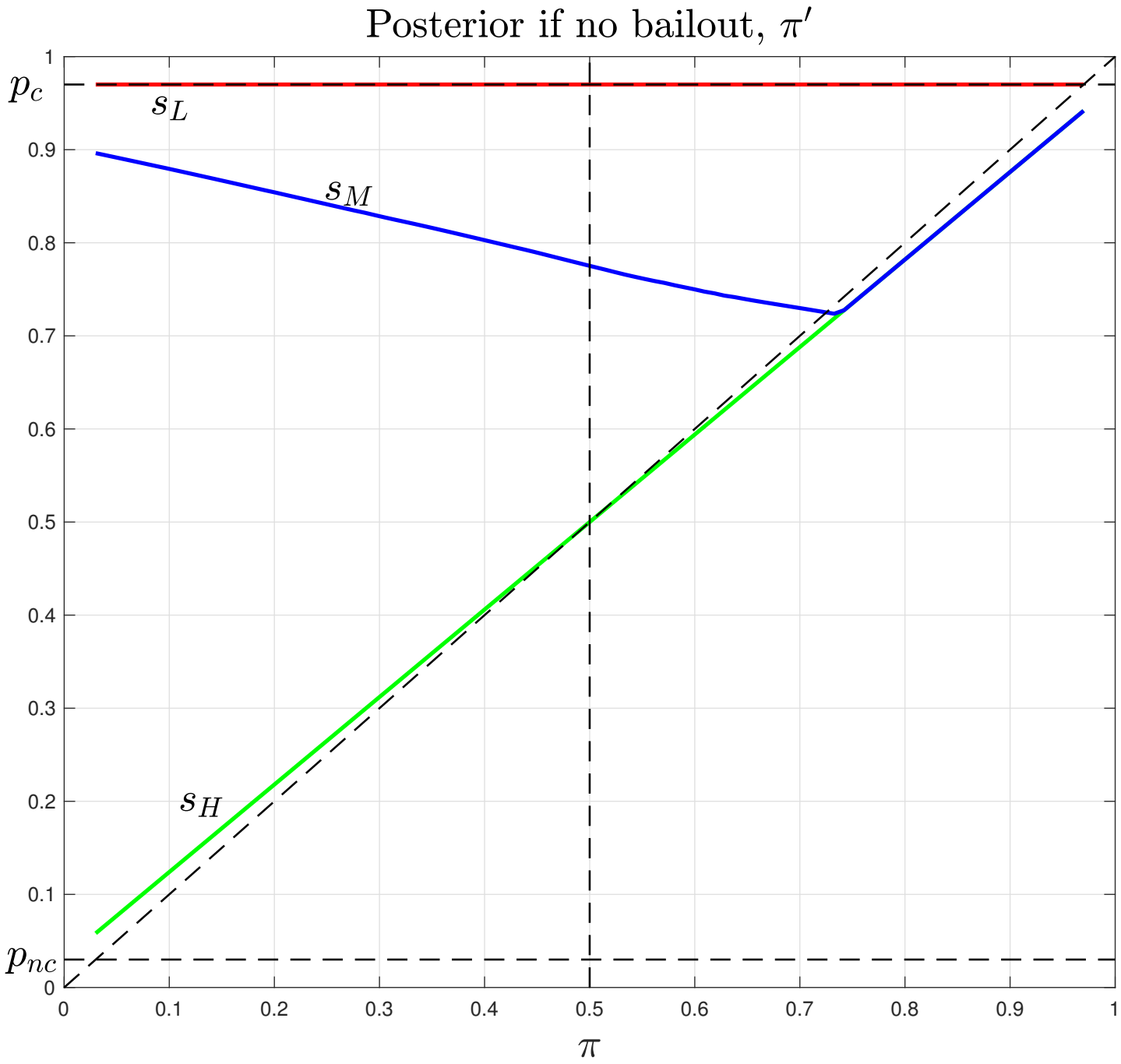
- If $\beta\left[W_1\left(p_{nc}+\pi\Delta p\right)-W_1\left(p_{nc}\right)\right] \geqslant \Delta\Omega\left(\pi, s|\,\sigma\right)$ then $\sigma(\pi, s)=0$
- If $\beta\left[W_1\left(p_c\right)-W_1\left(p_{nc}\right)\right] < \Delta\Omega\left(\pi, s|\,\sigma\right)$ then $\sigma(\pi, s)=1$
- Else $\sigma(\pi, s)$ solves

$$\beta\left[W_1\left(p_{nc}+\frac{\pi\Delta p}{\pi+(1-\pi)(1-\sigma)}\right)-W_1\left(p_{nc}\right)\right]=\Delta\Omega\left(\pi, s|\sigma\right)$$

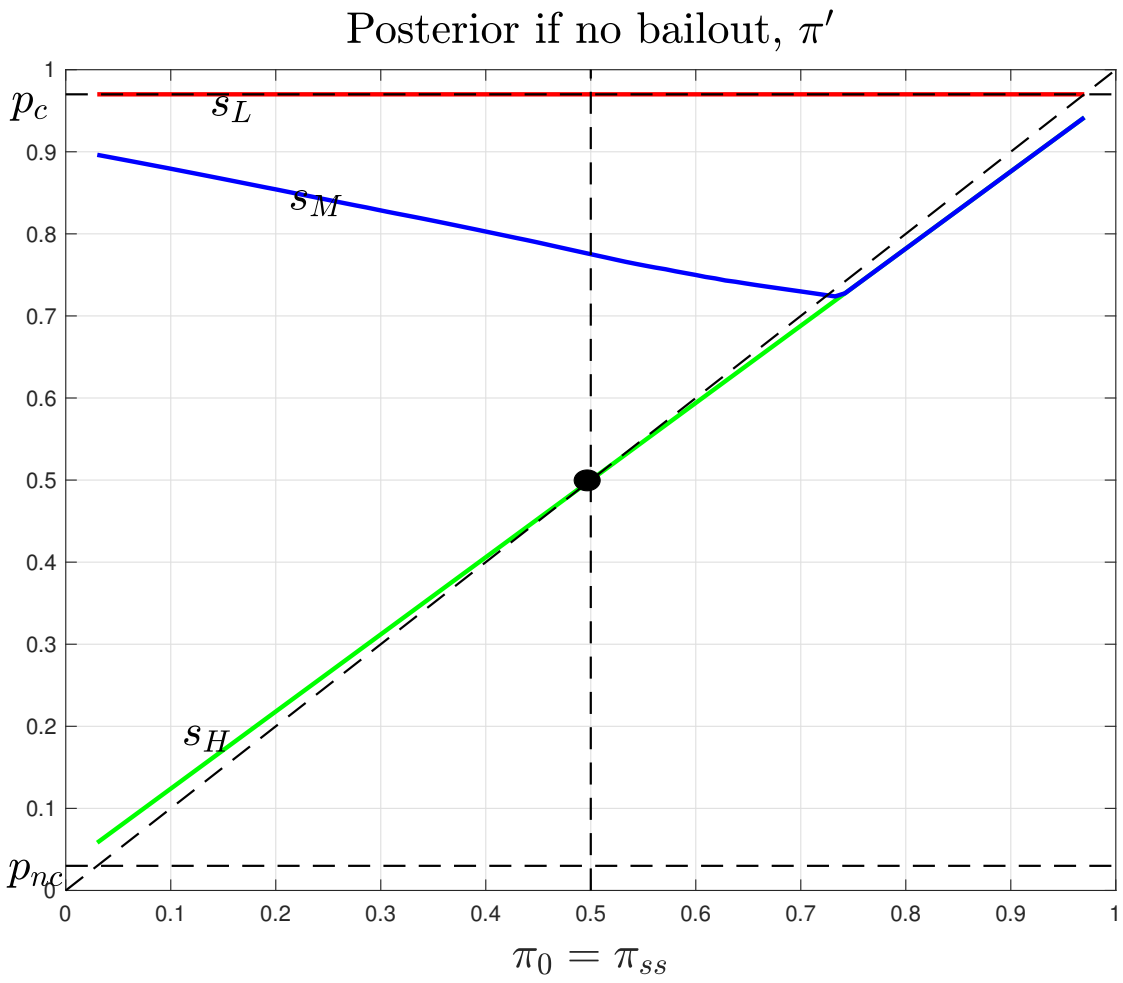
So:

- If $s=s_H$ then $\Delta\Omega=0$ so no need to bailout $\Rightarrow \sigma=0$
- If $s=s_L$ then $\Delta\Omega$ large enough so if β small enough then optimal to bailout $\Rightarrow \sigma=1$
- If $s=s_M$, if β intermediate then optimal to mix for intermediate values of π

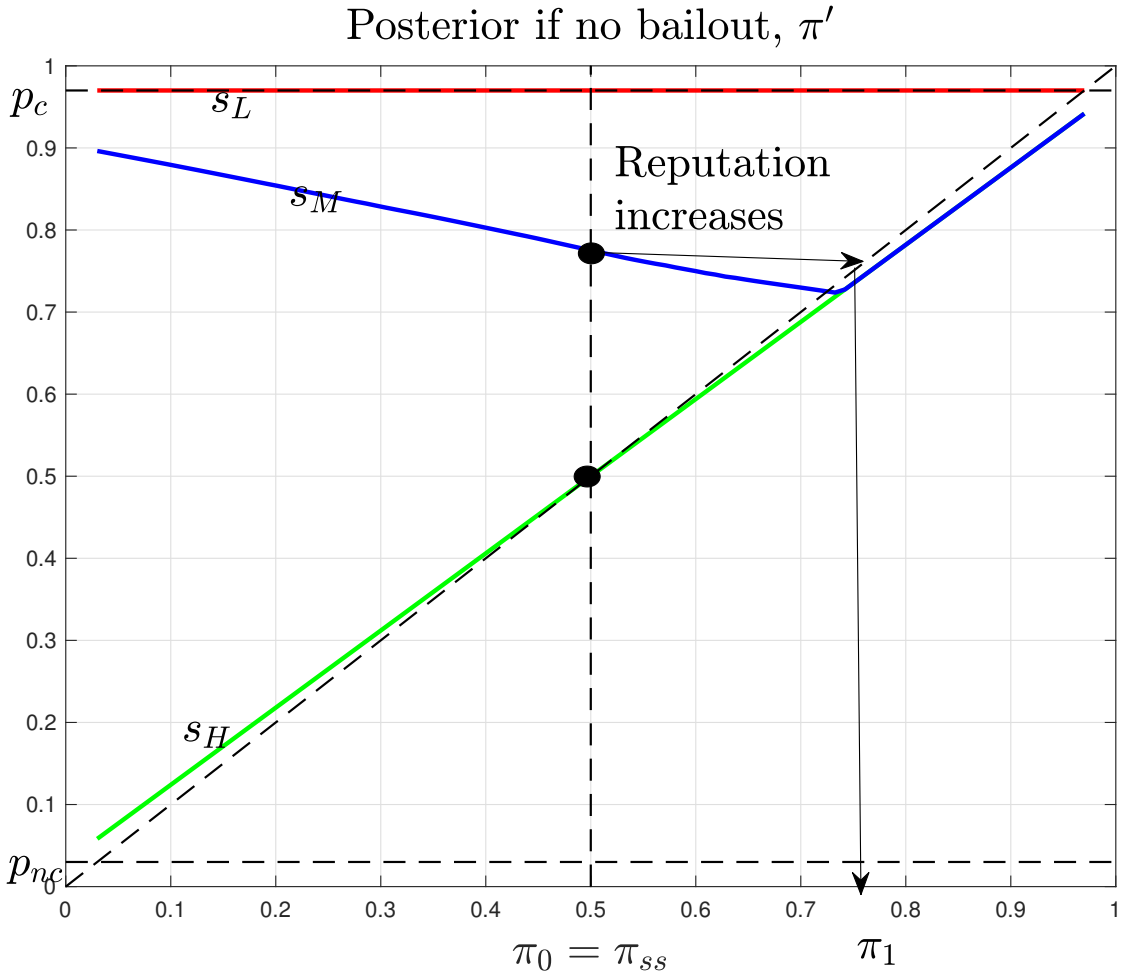

Probability of bailout, $\sigma(\pi, s)$
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
π
s_H
s_M
s_L


Posterior if no bailout, π'
p_c
p_{nc}
s_L
s_M
s_H
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
π

EQUILIBRIUM DYNAMICS

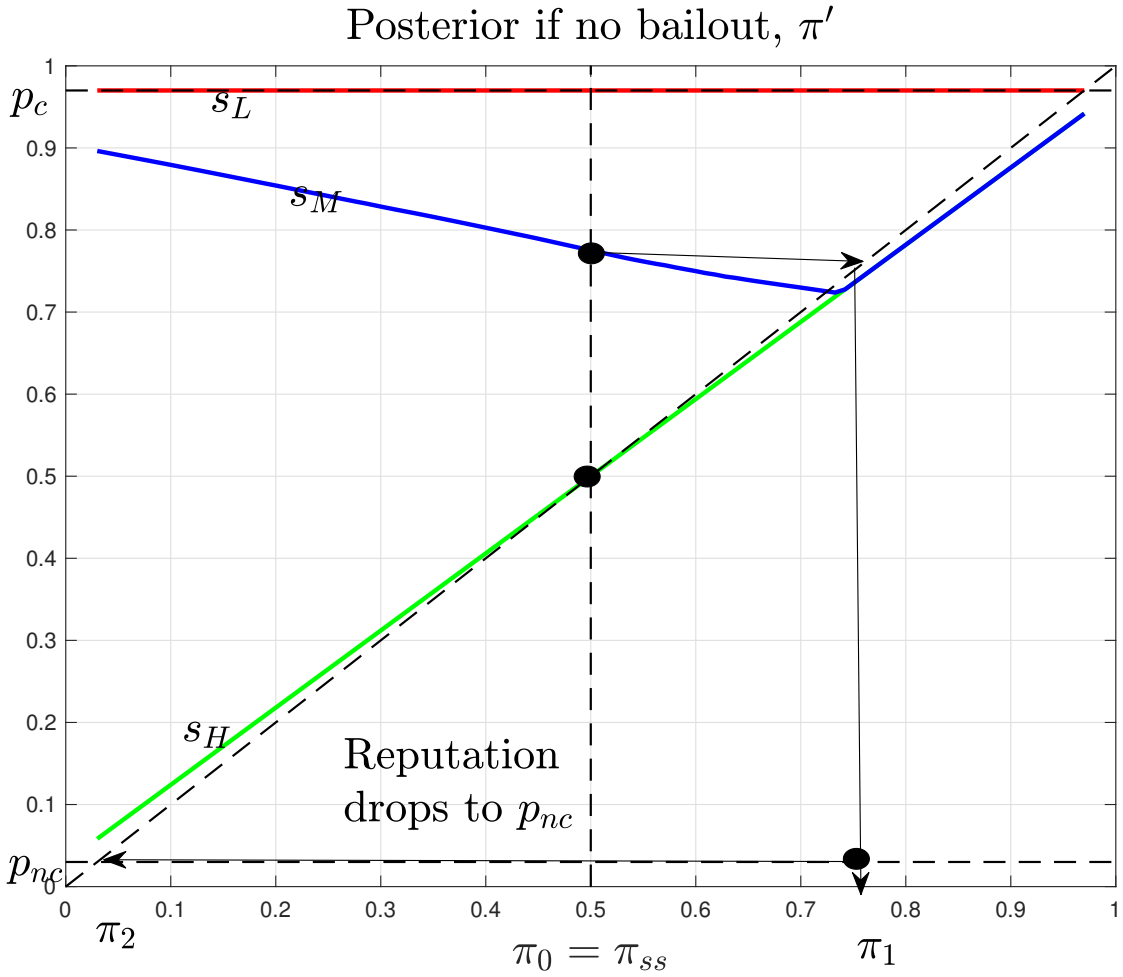


Suppose economy in normal times for long time so reputation π_{ss}



Enter a mild crisis, $s_1 = s_M$, then

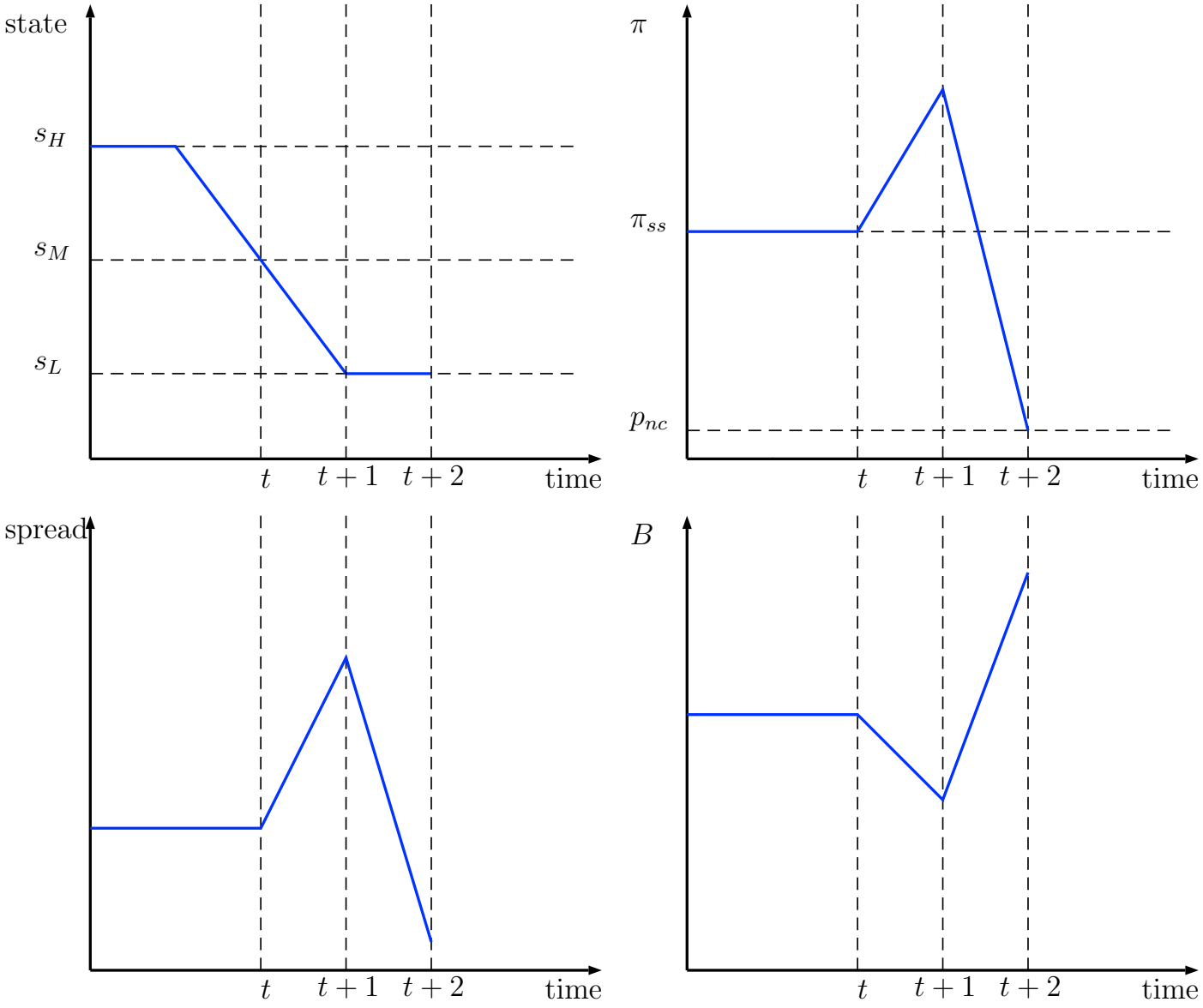
- Optimal to randomize
- If observe no bailout $\Rightarrow$ increase reputation
- Higher spreads and lower debt



Fundamentals worsen, enter a severe crisis, $s_2 = s_L$, then

- Static costs of no-bailout too large $\Rightarrow$ bailout for sure
- Reputation collapses to p_{nc}
- Lower spreads and higher debt

Equilibrium Outcome



CONTAGION AND SENSITIVITY TO FUNDAMENTALS

Extended Baseline Environment

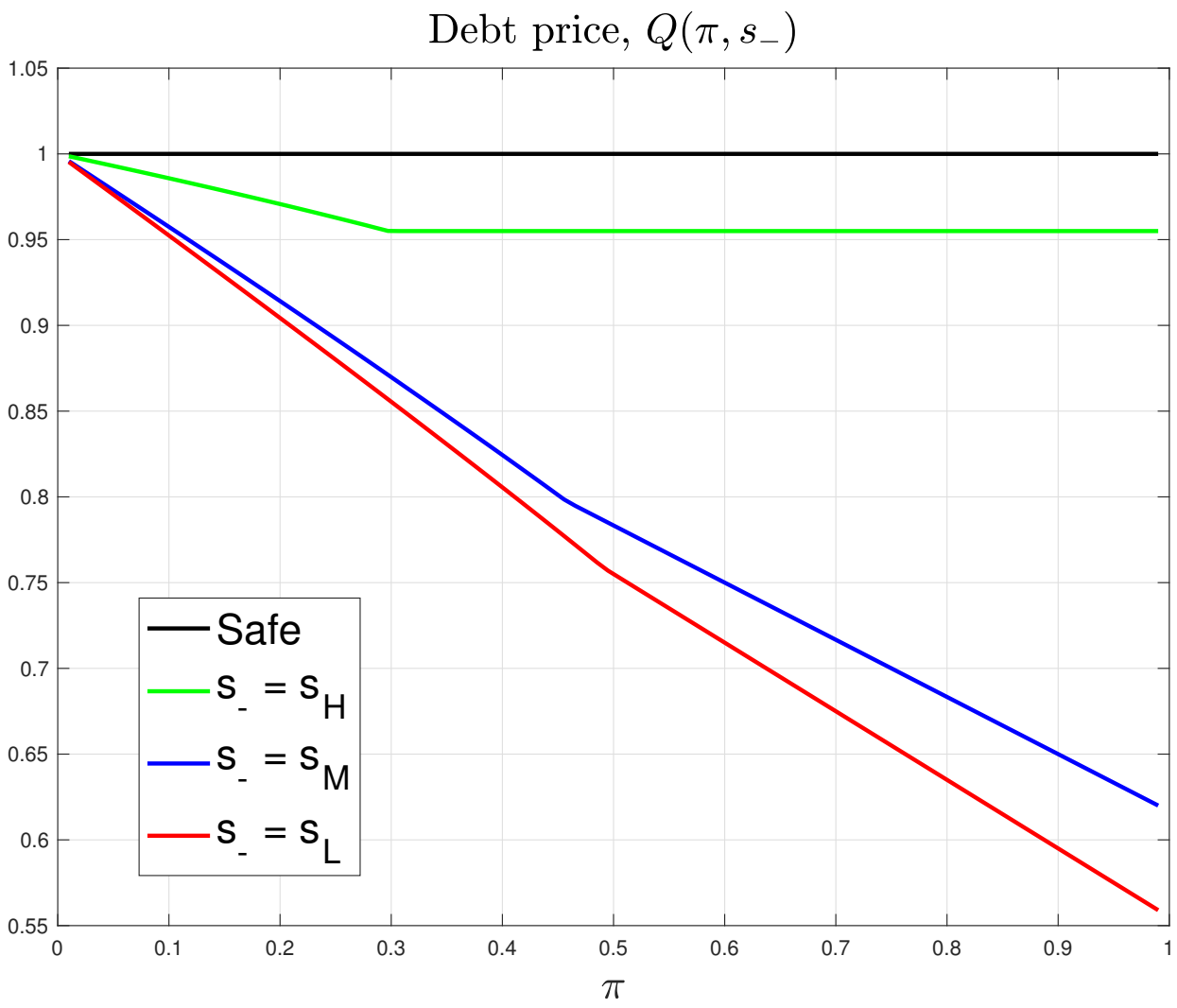
- Two type of borrower, {safe,risky}
  - For simplicity, for safe country θ_L cannot be realized
- Aggregate state s is persistent, $p(s'|s)$
- Idiosyncratic state is persistent, $h(\theta'|s', \theta)$
- All our characterization results unchanged
  - For appropriately modified sufficient conditions

Properties of Equilibrium

In mild recession, if observe no bailout

- Contagion
  - Spread increases for risky borrowers with θ_H
- Spread between risky and safe countries increases
- Increase in sensitivity of prices to fundamentals
  - Aggregates and idiosyncratic
  - Cole-Ordonez-Nehaun

Low Reputation ⇒ Low Sensitivity to Fundamentals

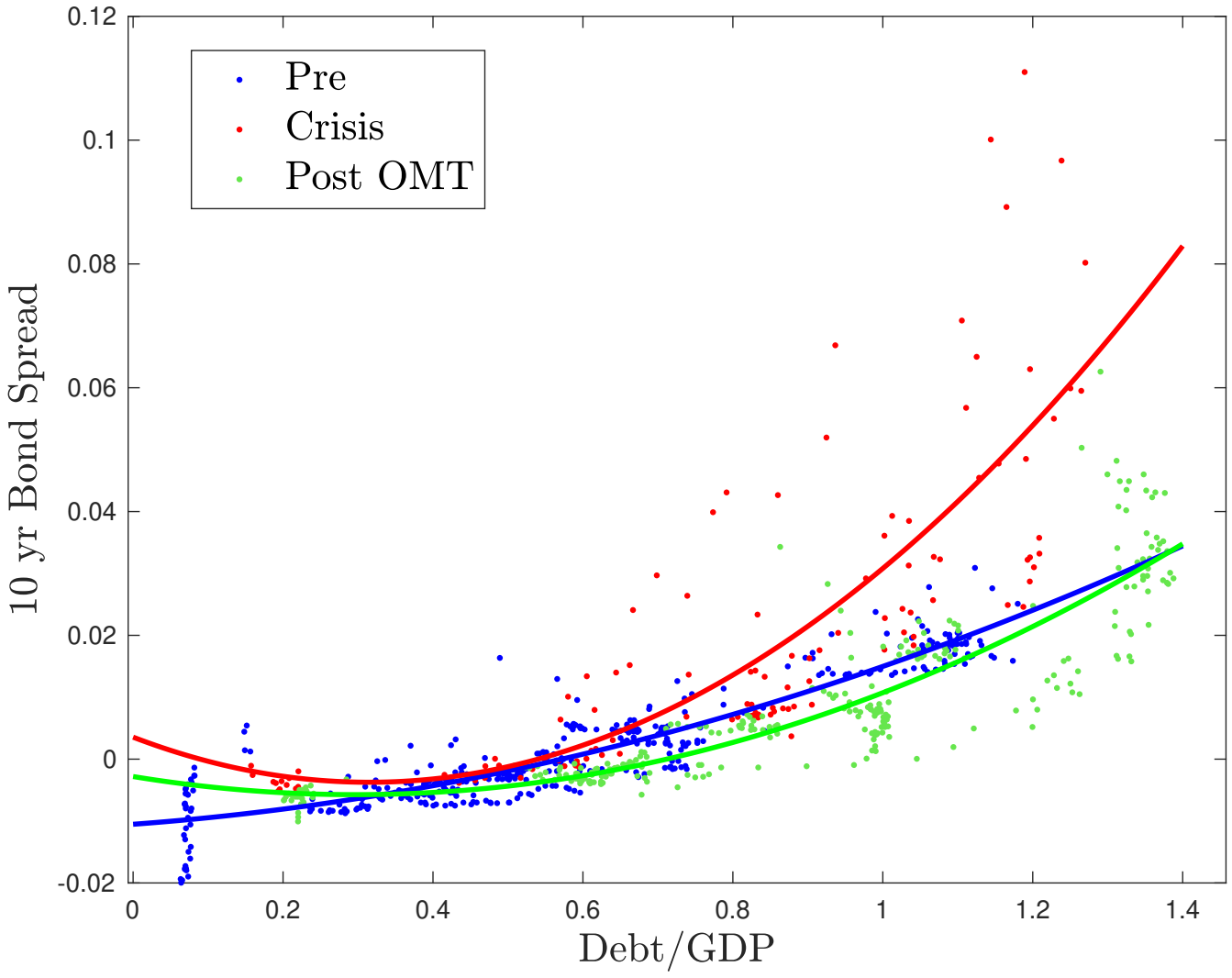


Back to Motivating Example

Eurozone debt crisis

- 2000-2009
  - Low reputation: low spreads, low sensitivity to fundamentals
- Crisis and lenders forced to get a haircut
  - High reputation: high spreads for risky countries, high sensitivity to fundamentals
- Crisis worsens and OMT
  - Low reputation: low spreads, low sensitivity to fundamentals

Eurozone: Sensitivity of Spreads to Fundamentals



Extensions

- Dynamic borrowers' problem
  - Bailing out few borrowers needed to avoid other defaults
  - Justify why observe bailouts of small fraction of borrowers

- Two-sided learning
  - Private agents learn bailout authority's type
  - Bailout authority learns state (asset prices+bailout requests)
  - Typical path has
    - Delayed bailout because learning about severity of crisis
    - If reputation low harder to learn: prices less sensitive to fundamentals

Conclusion

- Reputation model with learning about type of bailout authority
- Time varying expectations of bailouts from common bailout authority help to account for:
  - Hump-shaped dynamics for spreads around crises
  - Contagion
  - Higher sensitivity to fundamentals when reputation high
  - Delay in bailouts
- Work on measurement needed
  - For EU banks: Neuberg et al. (2018) work on CDS